Characterization of animals with microchips entering animal shelters

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Objective—To characterize animals with microchips entering animal shelters and the process used to find owners.

Design—Cross-sectional study.

Animals—7,704 microchipped animals entering 53 animal shelters between August 2007 and March 2008.

Procedures—Data for animals with microchips were recorded by participating animal shelters and reported monthly.

Results—Of 7,704 animals, strays accounted for slightly more than half (4,083 [53.0%]), with the remainder classified as owner-relinquished animals (3,225 [41.9%]) and other (396 [5.1%]). Of 3,425 stray animals for which animal shelters reported that the owner was found, a higher percentage of dog owners (2,191/2,956 [74.1%]) than cat owners (298/469 [63.5%]) was found. For 876 animals for which the owners could not be found, the main reasons were incorrect or disconnected telephone number (310 [35.4%]), owner did not return telephone calls or respond to a letter (213 [24.3%]), and animal was registered to another group (151 [17.2%]). Of 1,943 animals for which animal shelters contacted a microchip registry, 1,129 (58.1%) were registered in the database. Purebred neutered dogs whose owner information was in the shelter database registry or microchip registry had a higher likelihood that the owners would be found.

Conclusions and Clinical Relevance—The high rate for return of microchipped dogs and cats to their owners supported microchipping as a valuable permanent pet identification modality; however, issues related to registration undermined its overall potential. Bundling of microchip implantation and registration, point-of-implantation data registration, use of annual compliance and update reminders, and providing access to all registries are potential solutions. (*J Am Vet Med Assoc* 2009;235:160–167)

Although much attention has been given to the issues of microchip scanners and the various microchip frequencies available in the United States, little has been done to characterize the microchip registration process as it relates to reuniting lost pets with their owners.[1–3] The successful use of a microchip in reuniting a pet with its owner depends on a wide distribution of functional scanners that can read and detect the various frequencies used in a community, the willingness and ability of veterinarians and personnel at animal shelters to scan lost animals to detect a microchip, and a robust registration process whereby the owner information associated with a pet's microchip is registered with a microchip registry in which accurate up-to-date information is maintained by the owner as well as via active database management by the microchip registry.

The United States is the only country in which the implantation of a microchip is often treated as a separate process from registration with a microchip registry. In other countries, such as Canada and those throughout Europe, these services are always bundled together. Critics of the current microchip registry system in the United States cite several issues as complicating the registration process, including the fact that many animal shelters, veterinarians, breeders, and pet stores leave the registration process up to the owner, which results in low compliance; owners fail to maintain up-to-date information in the microchip registry; manual registration forms often lead to inaccurate information being entered into the microchip registry; and multiple registries exist in the United States.[3] On July 19, 2008, the AVMA House of Delegates approved a resolution that calls for the AVMA to actively promote the implementation of linking companion animal microchip databases.[4] Establishing such linkages should dramatically simplify the ability to return a lost companion animal to its owner.

Anecdotally, the animal shelter community reports major problems in reuniting microchipped pets with their owners because of a lack of registration, registra-

Abbreviations

OR	Odds ratio
RFID	Radiofrequency identification
RTO	Return to owner
SAWA	Society for Animal Welfare Administrators

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tion with another group (such as a veterinarian, animal shelter, rescue group, or breeder), and inaccurate owner information (such as disconnected or incorrect telephone numbers). The objectives of the study reported here were to characterize the animals with microchips entering animal shelters, describe the methods animal shelters used to find owners of animals, and identify factors associated with the ability of animal shelters to find the owner of a pet.

Materials and Methods

Sample population—Animal shelters (including publicly funded animal control shelters and privately funded humane societies) were recruited to participate in the study. Eligible animal shelters were those that scanned all animals that entered their shelters for microchips and were willing to enter data on each animal with a microchip into a computer spreadsheet. Animal shelters were primarily recruited during the summer of 2007 through an e-mail sent by the president of the National Animal Control Association to its members, a posting by one of the authors (LKL) on the SAWA listserve, and a short presentation by one of the authors (LKL) at the SAWA operations meeting in June 2007. Animal shelters were recruited from the National Animal Control Association and SAWA to obtain a diverse geographic representation of animal shelters throughout the United States.

Study procedures—Personnel at each animal shelter were provided with detailed instructions for collecting data and entering it into the spreadsheet template. At the beginning of each month, a spreadsheet template was e-mailed to each participating animal shelter for use in recording information on each animal entering the shelter and for which a microchip was found during scanning. Each shelter designated a primary person whose responsibility included collecting the information from shelter personnel and entering the data into the spreadsheet. At the end of each month, the completed spreadsheet was e-mailed back to the investigators. Reminders were sent to animal shelters that did not return their spreadsheets within 30 days after the end of a month. Animal shelters were not required to collect data for all months during the study (some shelters were unable to complete the study, and some started after the initial start date).

Drop-down menus were used in the spreadsheet to provide defined answers for each field entry in the spreadsheet to minimize errors in data entry. All data were reviewed monthly for entry errors, and the animal shelters were contacted (when necessary) to collect and validate missing or questionable data. Animal shelters were also e-mailed a survey on general microchip policies, which was completed and returned via e-mail.

In a preliminary study, the initial spreadsheet template was reviewed by several shelter veterinarians and operations directors for clarity and ease of use. Appropriate changes were made on the basis of this feedback. A preliminary study was then conducted with 45 shelters to test the collection of data by use of the modified spreadsheet template. Again, the spreadsheet template was revised on the basis of feedback prior to commencement of the study reported here.

Type of data collected—Three general categories of data were collected for the study.

Data on individual animals

When a microchip was detected in an animal entering an animal shelter, information was collected for animal identification number used by the shelter, species (dog, cat, or other), sex (neutered male, sexually intact male, spayed female, sexually intact female, or unknown), breed (mixed-breed animal or purebred), entry type (stray, owner relinquished, or other), microchip location (shoulder region, neck, left or right side, lumbar region, other, or unknown), scanning time when microchip was detected (entry to facility, initial evaluation, time of euthanasia, or other), brand of microchip (microchip A,[a] microchip B,[b] microchip C,[c] microchip D,[d] other, or unknown), brand of scanner used (scanner A,[a] scanner B,[b] scanner C,[d] or other), name of microchip registry when microchip manufacturer was contacted (registry A,[e] registry B,[f] registry C,[g] other, or did not contact), current owner registered in microchip registry (yes, no, did not contact microchip registry, or did not contact microchip registry because microchip was in the shelter database), able to find the animal owner (yes, no, or yes but not found by use of microchip information), owner wanted animal back (yes, no, or unknown), and person who inserted the microchip into the animal (personnel at an animal shelter, veterinarian, breeder, other, or unknown). Possible choices to describe how the owner for an animal was found were via a microchip registry database, shelter database, veterinarian, breeder, rescue group, pet store, or other. When an owner was not found by use of the microchip, options included owner did not return telephone calls or respond to a letter, incorrect or disconnected telephone number, animal registered to another owner, animal registered to another group (animal shelter or rescue group, breeder, veterinarian, or pet store), or no registration for the microchip.

Monthly numbers for animal shelters

Each month, participating animal shelters provided the total number of animals entering their facility. Numbers were provided for each species (dog, cat, or other) and on the basis of entry type (stray, owner relinquished, or other).

Overall information for each animal shelter

Information was collected on the type of agency, record keeping for animals microchipped by the animal shelter, policies on when animals were scanned, procedures followed when a microchip was detected in stray and owner-relinquished animals, number of brands of scanner used by a shelter, brand of microchip used, the criteria used to determine which animals received a microchip, whether laws on microchipping existed in the community, and the RTO rates for stray dogs and cats.

Data collection—Data were collected monthly beginning in August 2007 and ending in March 2008. Data were not collected during the months of April through June 2008 because animal shelters typically are busiest during that time and the burden of collecting the data

was increasingly difficult for some of the animal shelters participating in the study.

Statistical analysis—For normally distributed continuous data, mean and SD were calculated; median and range were calculated for all other continuous data. Proportions were calculated for responses that consisted of categoric data. The denominator for each categoric response was determined on the basis of the number of respondents answering a particular question (ie, every animal shelter did not answer every question). Specific comparisons to identify differences in responses between dogs and cats and between microchip registries were identified a priori. Comparisons were made among categoric variables by use of a χ^2 test. The Fisher exact test was used for categoric variables when the expected value of a given cell in the comparison was < 5.

Univariate mixed-effects logistic regression was used to evaluate potential predictors that an animal shelter would find the owner of an animal, with animal shelter treated as the random effect in the model. Variables with values of $P \leq 0.25$ in the univariate analyses were included in multivariate mixed-effects logistic regression analysis. Variables were removed from the full multivariate model on the basis of results of the Wald test. Biologically meaningful interactions between the main effect variables in the model were tested for inclusion in a similar manner. For all analyses, values of $P \leq 0.05$ were considered significant. Standard statistical software[h] was used for all analyses.

Results

A total of 53 shelters in 23 states participated in the study (mean ± SD duration of participation, 6.6 ± 1.7 months). General descriptive information on policies for scanning and implanting microchips was provided by 52 shelters (**Table 1**). Approximately three-fourths (41/52 [78.8%]) of the animal shelters scanned animals > 1 time during an animal's stay in the shelter. Almost all (44/52 [84.6%]) of the shelters maintained a shelter database of animals they implanted a microchip in before allowing it to leave the shelter. Almost half (23/52 [44.2%]) of the animal shelters used this internal database before contacting a microchip registry for animals entering their shelter.

Table 1—Description of 52 animal shelters that participated in a study on microchips in animals.

Variable	Category	No. (%)
Type of animal shelter	Nonprofit animal shelter	23 (44.2)
	Government animal control facility	15 (28.9)
	Nonprofit animal shelter with animal-control contracts	14 (26.9)
Animals scanned for microchips*	At entry to animal shelter	51 (98.1)
	During initial evaluation	34 (65.4)
	At time of euthanasia	34 (65.4)
	Other	15 (28.9)
Scanning frequency	Scan animal > 1 time	41 (78.8)
	Scan animal only 1 time	11 (21.2)
Policy for maintaining database	Maintain own shelter database	44 (84.6)
	Did not maintain own shelter database	6 (11.5)
	Not applicable (did not microchip animals)	2 (3.9)
Policy when microchip detected in owner-relinquished animal	Contact microchip registry	22 (42.3)
	Contact microchip registry only when person not in shelter database	13 (25.0)
	Check only shelter database	8 (15.4)
	Did not check any database	9 (17.3)
Policy when microchip detected in animal	Always contact microchip registry for owner information	29 (55.8)
	Only contact microchip registry when owner not in shelter database	23 (44.2)
No. of brands of scanners used by shelter	1	27 (51.9)
	2	22 (42.3)
	3	3 (5.8)
Brand of microchip implanted by shelter	B	18 (34.6)
	C	18 (34.6)
	A	11 (21.2)
	D	3 (5.8)
	None	2 (3.9)
Policy for microchipping of animals	Implant all adopted animals	30 (57.7)
	Implant some adopted animals	11 (21.2)
	Implant all animals leaving the shelter, including RTO animals	8 (15.4)
	Did not implant any adopted animals	3 (5.8)
Legal requirements for mandatory microchipping of animals leaving the shelter	No	48 (92.3)
	Yes	4 (7.7)

*Values total > 52 because respondents could select > 1 answer.

Information was collected on 7,704 animals with microchips (**Table 2**). Strays accounted for slightly more than half (4,083 [53.0%]) of the animals, with the remainder classified as owner-relinquished animals (3,225 [41.9%]) and other (396 [5.1%]). Most of the animals were dogs (6,185/7,692 [80.4%]). Approximately three-fourths (5,547/7,678 [72.3%]) were spayed females or neutered males, with a significantly ($P < 0.001$) higher proportion of cats (1,307/1,505 [86.8%]) being spayed or neutered, compared with the proportion of spayed or neutered dogs (4,240/6,173 [68.7%]).

General information on scanning process—Of the 7,704 animals, microchips were detected when animals were scanned at the time of entry to the animal shelter (6,712 [87.1%]), during initial evaluation (811 [10.5%]), at the time of euthanasia (82 [1.1%]), or at another time (99 [1.3%]). For 7,597 animals, the scanner used to detect the microchip was reported as scanner B (4,258 [56.1%]), scanner A (2,511 [33.1%]), scanner C (721 [9.5%]), or other (107 [1.4%]). Of the 992 (12.9%) microchips detected at times other than at entry to the animal shelter, 971 (97.9%) had not been detected when animals were scanned at an earlier time during the animal's stay in the shelter.

Location of the microchip when detected by the scanner was also reported for 6,001 animals (location for 1,703 animals was unknown). Of these 6,001 animals, 95 (1.6%) had microchips that were detected in regions other than the standard implantation site of the neck or shoulder region, and these chips were considered to have migrated after implantation. There was not a significant ($P = 0.576$) difference among brands of microchips for the percentage of microchips detected in these nonstandard regions.

The brand of microchip was detected for 7,607 animals in the study. Microchips detected were microchip B (3,216 [42.3%]), microchip A (2,689 [35.4%]), microchip C (1,533 [20.2%]), other (114 [1.5%]), or unknown (55 [0.7%]). For 5,144 animals, the shelters were able to determine the person who had implanted the animal with a microchip, with 4,132 (80.3%) implanted by personnel at an animal shelter, 621 (12.1%) implanted by a veterinarian, 192 (3.7%) implanted by a breeder, and 199 (3.9%) implanted by someone with another group.

Data for stray animals with microchips—Median number of stray animals with microchips for each animal shelter was 29 (range, 0 to 654), which included dogs (median, 24; range, 0 to 620) and cats (median, 3; range, 0 to 38). When expressed as a percentage of the total incoming number of stray animals for each animal shelter, strays with microchips accounted for a median of 1.8% (range, 0% to 20.6%) of the total strays for each shelter, which included dogs (median, 3.9%; range, 0% to 31.5%) and cats (median, 0.4%; range, 0% to 24.3%).

Of the 4,083 stray animals with microchips, complete data were provided for 4,068 animals. We excluded 619 animals because the animals were reclaimed by the owners before the shelters had an opportunity to determine owner information from the microchip. Data on the registration process for the remaining 3,449 animals were summarized (**Table 3**). A higher percentage of dogs (1,344/2,978 [45.1%]) than cats (162/471 [34.4%]) had microchip information recorded in the shelter databases; however, when these animals were excluded, there was not a significant ($P = 0.150$) difference between the percentage of dogs (938/1,634 [57.4%]) and cats (191/309 [61.8%]) registered in a microchip registry. Of the 3,425 animals for which the animal shelter reported whether the owner was found, a higher percentage of dog owners (2,191/2,956 [74.1%]) than cat owners (298/469 [63.5%]) was found, and more dog owners (1,658/2,191 [75.7%]) than cat owners (182/298 [61.1%]) wanted their animal back from the animal shelter. For the 876 animals for which the owners could not be found, the main reasons were incorrect or disconnected telephone number (310 [35.4%]), owner did not return telephone calls or respond to a letter (213 [24.3%]), and animal was registered to another group (151 [17.2%]).

As expected, a much higher percentage of owners was found when the owner information was in the shel-

Table 2—Description of animals with microchips entering 53 animal shelters.

	Stray		Owner relinquished		Other		Total	
Variable	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**
All animals	4,083	53.0	3,225	41.9	396	5.1	**7,704**	**100**
Species (n = 7,692)								
Dog	3,576	57.8	2,312	37.4	297	4.8	**6,185**	**100**
Cat	500	33.2	908	60.3	99	6.6	**1,507**	**100**
Sex (n = 7,678)								
Male	2,398	56.4	1,646	38.7	210	4.9	**4,254**	**100**
Female	1,632	48.5	1,549	46.0	185	5.5	**3,366**	**100**
Unknown	38	65.5	19	32.8	1	1.7	**58**	**100**
Spay-neuter status (n = 7,678)								
Spayed or neutered	2,577	46.5	2,683	48.4	287	5.2	**5,547**	**100**
Sexually intact	1,453	70.1	512	24.7	108	5.2	**2,073**	**100**
Unknown	38	65.5	19	32.8	1	1.7	**58**	**100**
Breed (n = 7,619)								
Purebred	1,350	63.8	670	31.7	96	4.5	**2,116**	**100**
Mixed	2,712	49.3	2,491	45.3	300	5.5	**5,503**	**100**

ter database (1,291/1,498 [86.2%]) or registered in one of the microchip registries (863/1,121 [77.0%]), compared with the percentage of owners with no registration in the microchip registries (335/806 [41.6%]). Of the 1,943 animals for which personnel at the animal shelters contacted a microchip registry, 1,129 (58.1%) were registered in the database. Of the animals for which a microchip registry was contacted, registry C had a significantly ($P < 0.001$) higher percentage of animals registered (303/384 [78.9%]), compared with the percentage of animals registered for registry A (343/676 [50.7%]), registry B (422/794 [53.2%]), or other registries (61/89 [68.5%]). However, there was not a significant ($P = 0.756$) difference among the microchip registries contacted with regard to an animal shelter's ability to find the owner.

Overall, the RTO rates for stray animals with microchips were much higher than the overall RTO rates for the animal shelters. The overall median RTO rate for stray dogs was 21.9% (range, 0% to 97.5%), whereas the median RTO rate for stray dogs with microchips was 52.2% (range, 0% to 100%). The overall median RTO rate for stray cats was 1.8% (range, 0.1% to 86.2%), whereas the median RTO rate for stray cats with microchips was 38.5% (range, 0% to 100%).

Data for owner-relinquished animals with microchips—The median number of owner-relinquished animals with microchips for each shelter was 19 (range, 0 to 500), which included dogs (median, 12; range, 0 to 346) and cats (median, 5.5; range, 0 to 154). When expressed as a percentage of the total number of owner-relinquished animals for each shelter, owner-relinquished animals with microchips accounted for a median of 2.2% (0% to 25.0%) of the total owner-relinquished animals for each shelter, which included dogs (median, 3.1%; range, 0% to 42.4%) and cats (median, 0.6%; range, 0% to 13.6%).

Of the 3,225 owner-relinquished animals, shelters collected registration data for 3,110 animals. Animal shelters accepted 793 (25.5%) animals without any verification that the person relinquishing the animal was the rightful owner, whereas 1,441 (46.3%) owners were verified in the shelter database. Of the remaining 876 animals, 466 (53.2%) were registered in a microchip registry, and 410 (46.8%) did not have any registration. For 192 owner-relinquished animals for which someone other than the owner relinquished the animal, animal shelters reported attempting to find the original owner. For 110 (57.3%), the owner was found; however, of these 110 owners, only 15 (13.6%) wanted the animal returned.

Factors associated with finding the owner of a stray animal—Data for 3,379 animals were used for the mixed-effects logistic regression analysis to investigate factors associated with finding the owner of a stray animal. Animals with missing values for variables in the model or animals with an unknown spay or neuter status were not included. Factors considered included species, breed, sex, spay or neuter status, and registration status; all factors were found to be significant in

Table 3—Data on 3,449 stray animals with microchips entering 53 animal shelters.

	Dog		Cat		Total	
Variable	**No.**	**%**	**No.**	**%**	**No.**	**%**
Registration status ($P < 0.001$)						
Registered in microchip registry	938	31.5	191	40.6	**1,129**	**32.7**
Data in shelter database	1,344	45.1	162	34.4	**1,506**	**43.7**
Not registered in any microchip registry	696	23.4	118	25.1	**814**	**23.6**
Owner registered in microchip registry ($P = 0.150$)						
Yes	938	57.4	191	61.8	**1,129**	**58.1**
No	696	42.6	118	38.2	**814**	**41.9**
Animal shelter able to find owner ($P < 0.001$)						
Yes	2,191	74.1	298	63.5	**2,489**	**72.7**
No	765	25.9	171	36.5	**936**	**27.3**
Owner wanted animal returned ($P < 0.001$)						
Yes	1,658	75.7	182	61.1	**1,840**	**73.9**
No	423	19.3	99	33.2	**522**	**21.0**
Unknown	110	5.0	17	5.7	**127**	**5.1**
Method used to find owner ($P = 0.003$)						
Microchip registry	706	33.0	126	43.8	**832**	**34.3**
Shelter database	1,219	57.0	143	49.7	**1,362**	**56.1**
Information obtained from veterinarian	98	4.6	9	3.1	**107**	**4.4**
Other*	115	5.4	10	3.5	**125**	**5.2**
Unable to find owner ($P = 0.941$)						
Incorrect or disconnected telephone number	247	34.8	63	38.0	**310**	**35.4**
Owner did not return telephone calls or respond to a letter	175	24.7	38	22.9	**213**	**24.3**
Different owner	96	13.5	20	12.1	**116**	**13.2**
Not registered in microchip database	70	9.9	16	9.6	**86**	**9.8**
Microchip registered to another group	122	17.2	29	17.5	**151**	**17.2**

Values were considered significant at $P \leq 0.05$.
*Other includes information obtained from a breeder, pet store, or rescue group.

Table 4—Results for multivariate mixed-effects logistic regression analysis of factors associated with finding the owners of 3,419 stray animals with microchips at 53 animal shelters.

Variable	Adjusted OR	95% CI	*P* value
Species			
Cat	1.0	Referent	NA
Dog	1.7	1.33–2.18	< 0.001
Breed			
Mixed	1.0	Referent	NA
Purebred	1.5	1.23–1.82	< 0.001
Spay-neuter status			
Sexually intact	1.0	Referent	NA
Spayed or neutered	1.8	1.54–2.18	< 0.001
Registration status			
Not registered in microchip registry	1.0	Referent	NA
Registered in microchip registry	4.9	3.96–5.96	< 0.001
Data in shelter database	8.7	7.03–10.79	< 0.001

CI = Confidence interval. NA = Not applicable.

the final multivariate model, except for sex (**Table 4**). Dog owners were 1.7 times as likely to be found as were cat owners, owners of purebred animals were 1.5 times as likely to be found as were owners of mixed-breed animals, and owners of spayed or neutered animals were 1.8 times as likely to be found as were owners of sexually intact animals. An owner whose information was in the microchip registry was 4.9 times as likely to be found, and in the shelter database 8.7 times as likely to be found, as was an owner whose information was not in the microchip registry.

Discussion

Results of the study reported here indicated that animal shelters were able to find the owners of almost three-fourths of stray dogs and cats with microchips. The ability to find the owners was higher for dogs, animals that were purebred, and animals that were spayed or neutered. Animal shelters had a much higher likelihood of finding an owner when the owner information was in the shelter's own database (OR = 8.7) or registered with a microchip registry (OR = 4.9). The latter finding indicates the importance of the registration process in successfully reuniting pets and owners. In addition, animal shelters had a much higher RTO rate for strays with microchips, compared with the overall RTO rate, which supports the notion that microchips are an important method to reunite lost pets with owners. In another study[5] in which methods that owners use to search for lost dogs were described, only 2 of 15 (13%) dogs with microchips were recovered by their owners, which is significantly lower than the 2,191 (74.1%) dog owners the animal shelters found in the study reported here. However, that study[5] included efforts only for recovery of pets by pet owners, and therefore it was unknown whether those dogs were ever scanned for a microchip by personnel at an animal shelter or by a veterinarian. This difference reflects the critical role that animal shelters and veterinarians can play in the reunification process because of their ability to scan animals for microchips.

In the study reported here, 11 of 52 (21.2%) animal shelters scanned an incoming animal only 1 time during its stay in the shelter. However, an additional 971 (12.6%) animals scanned > 1 time were found to have microchips, which indicated that a microchip can be missed during the first scan. In addition, 91 (1.6%) microchips were found implanted in a nonstandard implantation site, which indicated migration of the microchip. Both of these findings support the results of other studies[1,2] that emphasize the importance of scanning animals > 1 time and use of proper technique. Scanning > 1 time is especially critical given that scanners do not have 100% sensitivity in detecting or reading microchips.[1,2] Therefore, scanning protocols at animal shelters should include scanning at various routine times during animal handling, such as at entry, during medical evaluations, and prior to euthanasia. The same philosophy would apply to veterinary clinics whereby office staff and veterinary technicians could scan stray animals brought to their facilities. In addition, veterinary clinic staff should scan microchipped animals during each wellness examination to ensure that the microchip is still functional and has not migrated. The migration rate of 1.6% in our study is higher than that reported by the British Small Animal Veterinary Association.[3] In that study, evaluations of animals between 1996 and 2007 revealed that 205 microchips migrated in a country in which > 4 million animals have microchips. However, reporting was voluntary in that study[3]; thus, the migration rate may have been higher. Additional studies are needed to better understand the importance of migration and its potential impact on microchip detection.

Despite the high percentage of owners who were found by the animal shelters in the study reported here, problems were encountered with the microchip registration process. For animals in which the shelters contacted the microchip registries, only 1,129 (58.1%) were registered. Although some of the owners who were not registered were found by other methods, such as obtaining the owner information through the original group who implanted the microchip in the animal, this required a substantial amount of additional time for the shelter staff and increased the risk that the owner would not be found. The major reasons that animal shelters were unable to find the owners were largely re-

lated to incorrect owner information, such as an incorrect or disconnected telephone number, the microchip was registered to a different owner (which indicated the animal was not with the person who owned the dog at the time of microchip implantation), or the microchip was still registered to the group that had implanted the microchip. In addition, the microchip registries were unable to provide any information on the owner or person who originally implanted the microchip for 86 (9.8%) animals.

Findings in our study also can be used to emphasize the importance for personnel at animal shelters to scan owner-relinquished animals and verify ownership via a microchip registry. A person relinquishing an animal to an animal shelter may not be the rightful owner. For example, a person may find a dog or cat, keep it for several months, and then decide to relinquish it to an animal shelter. The rightful owner may still want to reclaim the pet. Animal shelters can be certain that the person relinquishing the animal is the rightful owner only through verification of the microchip registration information. We found that 9 (17.3%) animal shelters did not make any attempt to verify owner information and that for shelters that did attempt to verify information, 15 owners wanted to reclaim the pet that was relinquished by another person.

An effective RFID system is based on the integrated functionality of 3 critical components: the microchip, the scanner, and the supportive microchip registry or database. System issues related to technology were the focus of 2 studies,[1,2] and these issues are being addressed through the availability of universal scanners and standardization of technology. As a result, increased focus is now being placed on the service aspect of an RFID system (ie, the supportive microchip registry or database). Registry issues can be subdivided into 2 broad categories: registry access (for registration and for recovery) and data content.

With regard to registry content, it is important that owners initially register their information in a microchip registry and that they maintain up-to-date information. The microchip registries should maintain detailed data on who originally purchased the microchips to assist in tracking animals. Veterinarians and personnel at animal shelters can be instrumental in this process by ensuring a linkage between the implantation procedure and the registration process and by including the registration fee, if any, with the implantation fee. Veterinarians can also assist by reminding owners of microchipped animals (during the animal's regularly scheduled wellness examinations) to update their contact information with the microchip registry. Microchip registries can inexpensively send e-mail reminders to owners to update their information and can use other database-cleansing techniques, such as verification of US Postal Service addresses, to maintain up-to-date information.

Ideally, point-of-implantation data and registration information should be collected. This can be facilitated by use of appropriate technology and by the registry provider. Veterinarians and personnel at animal shelters can collect registration information from owners at the time of implantation and send the information directly to the microchip registries. Microchip registries can streamline this process by providing mechanisms to automatically upload the registration information directly from the software programs used by veterinary clinics or animal shelters; this should help avoid entry of illegible or inaccurate data on manually completed forms.

An additional problem that can compound issues relating to registry access is that owners can register their information in > 1 microchip registry. Typically, personnel at animal shelters and veterinary clinics only contact the microchip registry of the company that manufactured the microchip identified in an animal. It is not realistic to expect staff at animal shelters and veterinary clinics to contact every microchip registry. Instead, a microchip registration interface should be implemented that would allow personnel at animal shelters or veterinary clinics to enter a microchip number and receive the name and phone number of the microchip registry or registries that contain the owner information. Such a system exists in Europe. It is called EuroPetNet, and it is instrumental in helping groups locate owner information for multiple registries while still protecting owner privacy.[6] A similar functioning access system that is common to all RFID system providers would require the cooperation of all of the microchip manufacturers and registries to provide the unique microchip identification numbers. Further exploration of this system is needed in the United States and is supported by adoption of a resolution by the AVMA House of Delegates.[4]

However, access issues are but 1 component of registry performance, and improving on registry access is not a panacea for all registry issues. There are many functionality characteristics of an effective microchip registry, and this highlights the need to review any microchip database as well as the technology provided when performing due diligence in selecting an RFID system provider. Other important issues to consider when selecting an RFID provider should include customer service support, efforts to optimize database integrity, proactive assistance with pet recovery, and fees charged to owners for these services.

The highest percentage of owners was found through the use of information in the animal shelter databases. This is largely attributable to the fact that personnel at animal shelters were likely to have originally implanted most of the animals with microchips that enter their facilities. This study illustrated that the shelter database was highly effective for use in finding owners, but this was not true for animals implanted by other groups and for animals whose owners have moved out of the shelter area. It is important for animal shelters to register the owner information with a microchip registry for all animals they implant in case the animals are scanned at another animal shelter or by a veterinarian.

The study reported here had several limitations. The biggest limitation was the convenience sample of 53 animal shelters that participated in the study. Only shelters with the ability to track microchip data for individual animals and shelters that scanned all incoming animals were eligible to participate. Another limitation was that shelters were only recruited from 2 large national animal shelter organizations,

which may not have accurately represented all shelters in the United States. However, given that a comprehensive, up-to-date list of shelters was not available, this was considered the best method for recruitment. Nevertheless, these animal shelters may not have represented the practices used by all shelters in the United States, and care should be taken in extrapolating the results. Data were also collected for only 8 months, and it is possible that seasonal differences could have existed, although this would not be expected given the nature of the data.

a. Avid, Norco, Calif.
b. Digital Angel Inc; distributed by Intervet/Schering-Plough, Kenilworth, NJ.
c. Allflex USA Inc; distributed by PetHealth Inc, Rolling Meadows, Ill.
d. Datamars SA, Switzerland; distributed by Bayer Animal Health, Shawnee Mission, Kan.
e. PETtrac Database, Avid, Norco, Calif.
f. HomeAgain Pet Recovery System, Intervet/Schering-Plough, Kenilworth, NJ.
g. PetPoint Shelter Data Management System, PetHealth Inc, Rolling Meadows, Ill.
h. Stata, version 10.0, StataCorp, College Station, Tex.

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1. Lord LK, Pennell ML, Ingwersen W, et al. In vitro sensitivity of commercial scanners to microchips of various frequencies. *J Am Vet Med Assoc* 2008;233:1723–1728.
2. Lord LK, Pennell ML, Ingwersen W, et al. Sensitivity of commercial scanners to microchips of various frequencies implanted in dogs and cats. *J Am Vet Med Assoc* 2008;233:1729–1735.
3. AVMA. *Microchipping of animals*. AVMA Web site. Available at: www.avma.org/issues/microchipping/microchipping_bgnd.asp. Accessed Sep 12, 2008.
4. Kahler SC. House of delegates acts on resolution. *J Am Vet Med Assoc* 2008;233:688, 690, 699.
5. Lord LK, Wittum TE, Ferketich AK, et al. Search and identification methods that owners use to find a lost dog. *J Am Vet Med Assoc* 2007;230:211–216.
6. Europetnet. Europetnet Web site. Available at: www.europetnet.com/Home.aspx. Accessed Sep 14, 2008.